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(54) PROCEDE ET DISPOSITIF POUR L'IDENTIFICATION ET LE TRI D'OBJETS TRANSPORTES SUR BANDE
(54) METHOD AND DEVICE FOR IDENTIFYING AND SORTING OBJECTS CONVEYED ON A BELT

(57)

The invention relates to a method for identifying and sorting objects which are conveyed on a belt, especially for sorting waste. The nature of the material that the objects consist of is determined spectroscopically using an NIR measuring device (13) and the objects are sorted according to the result of the spectroscopy in that they are removed from the conveyor belt (7, 8, 9). According to the invention, the shape and/or the nature of the surfaces of the objects and the position of the objects on the conveyor belt (7, 8, 9) are determined (12) before the nature of the material that they consist of. The objects are then scanned by the measuring point (19) of the NIR measuring device (13) according to at least their position and removed from the conveyor belt (7, 8, 9). This guarantees a high identification and sorting rate and ensures that the system functions reliably.

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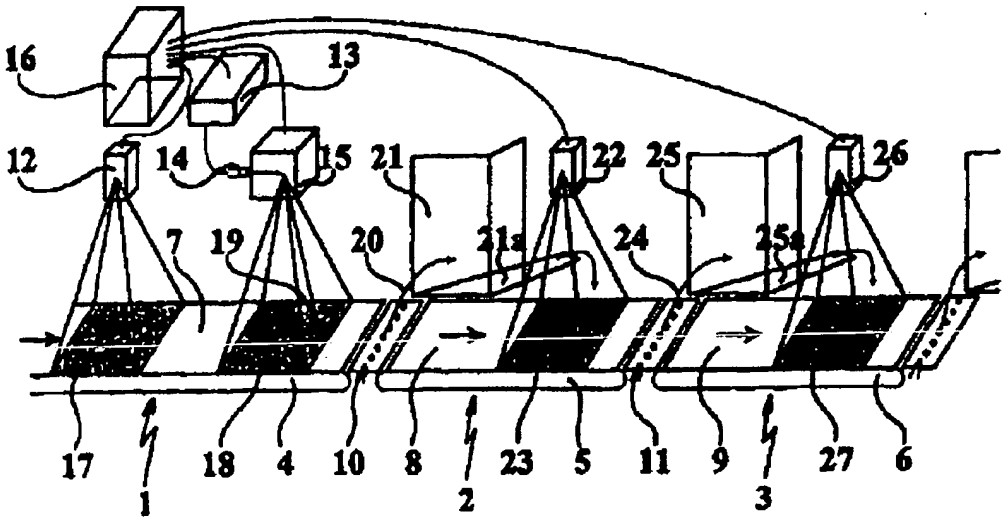
(54) **PROCEDE ET DISPOSITIF POUR L'IDENTIFICATION ET LE TRI D'OBJETS TRANSPORTES SUR BANDE**

(54) **METHOD AND DEVICE FOR IDENTIFYING AND SORTING OBJECTS CONVEYED ON A BELT**



(57) L'invention concerne un procédé pour l'identification et le tri d'objets transportés sur bande, en particulier pour le tri de déchets. Dans le procédé selon l'invention, on détecte la nature des matériaux des objets par spectroscopie à l'aide d'un appareil de mesure à proche infrarouge (13) et on procède au tri en fonction du résultat de la spectroscopie en enlevant des objets de la bande transporteuse (7, 8, 9). Afin de garantir un taux d'identification et de tri élevé ainsi qu'un fonctionnement sûr, on détecte (12) la forme et/ou la nature de la surface des objets et leur position sur la bande transporteuse (7, 8, 9) avant de détecter la nature de leurs matériaux, et on balaie les objets à travers le point de mesure (19) de l'appareil de mesure à proche infrarouge (13) puis on les ôte de la bande transporteuse en fonction d'au moins leur position.

(57) The invention relates to a method for identifying and sorting objects which are conveyed on a belt, especially for sorting waste. The nature of the material that the objects consist of is determined spectroscopically using an NIR measuring device (13) and the objects are sorted according to the result of the spectroscopy in that they are removed from the conveyor belt (7, 8, 9). According to the invention, the shape and/or the nature of the surfaces of the objects and the position of the objects on the conveyor belt (7, 8, 9) are determined (12) before the nature of the material that they consist of. The objects are then scanned by the measuring point (19) of the NIR measuring device (13) according to at least their position and removed from the conveyor belt (7, 8, 9). This guarantees a high identification and sorting rate and ensures that the system functions reliably.

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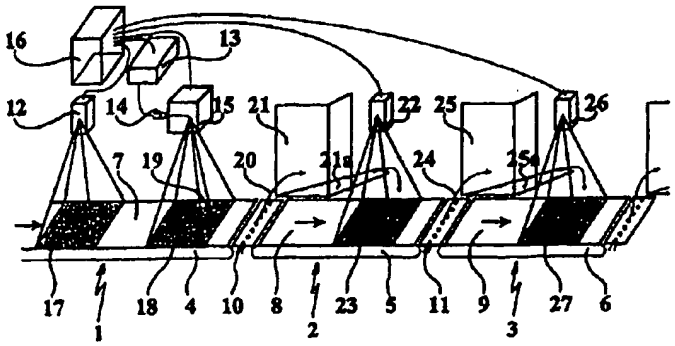
(54) Title: METHOD AND DEVICE FOR IDENTIFYING AND SORTING OBJECTS CONVEYED ON A BELT

(54) Bezeichnung: VERFAHREN UND VORRICHTUNG ZUM IDENTIFIZIEREN UND SORTIEREN VON BANDGEFÖRDERTEN OBJEKTEN



(57) Abstract

The invention relates to a method for identifying and sorting objects which are conveyed on a belt, especially for sorting waste. The nature of the material that the objects consist of is determined spectroscopically using an NIR measuring device (13) and the objects are sorted according to the result of the spectroscopy in that they are removed from the conveyor belt (7, 8, 9). According to the invention, the shape and/or the nature of the surfaces of the objects and the position of the objects on the conveyor belt (7, 8, 9) are determined (12) before the nature of the material that they consist of. The objects are then scanned by the measuring point (19) of the NIR measuring device (13) according to at least their position and removed from the conveyor belt (7, 8, 9). This guarantees a high identification and sorting rate and ensures that the system functions reliably.

METHOD AND DEVICE FOR IDENTIFYING AND SORTING OBJECTS CONVEYED ON A BELT

The invention relates to a method for identifying and sorting belt-conveyed objects, particularly for sorting refuse, in which the material characteristics of the objects are spectroscopically determined by means of a NIR measuring instrument and sorting takes place as a function of the spectroscopy result by removing objects from the conveyor belt. The invention also relates to an apparatus for performing this method.

In a known method of this type using NIR spectroscopy for determining the material characteristics of objects to be sorted it has hitherto been necessary to transfer the objects by conveyor belt to a stationary measurement point. This requires considerable effort in orienting the objects to be identified.

It is also known to use a conveyor belt having a maximum width of 70 cm in order to sort out material by blowing following the investigation of the characteristics thereof, it being a question of sorting out plastic objects, namely composite material packs. This method is based on a spinning mirror, which guides a measurement point in semicircular movements over the relatively narrow conveyor belt. At all points covered by the measurement point an extremely rapid NIR measurement is carried out with over 1,000 scans per second. This requires a special NIR measuring instrument, which in each case only reacts to a specific object material. A different NIR measuring instrument is required for a different object material.

DE 43 05 006 A1 discloses another method for identifying and sorting belt-conveyed objects. The determination of the material characteristics of the objects to be sorted takes place by means of a polarization interferometer and a fast Fourier analysis is used for evaluating the data supplied by said interferometer. Such an instrument for determining the material characteristics of the objects to be identified and sorted also has a detection area substantially limited to a single measurement point and is also subject to the same disadvantages as described hereinbefore, i.e. a relatively complicated presorting and separation or individualization are necessary before the objects are supplied to the punctiform measurement point. In addition, such a measuring instrument is critical with respect to the distance from the measured object.

A method according to the preamble of claim 1 and an apparatus according to the preamble of claim 5 are known from WO 94/25186. The image-giving system is used there in order to find position information via locations of the objects to be sorted, where an undisturbed determination of the material type is possible and where the measurement spot is consequently not falsified by labels, metal imprints or the like on the objects to be measured. The objects to be investigated must for this purpose be specifically moved up to the NIR measuring instrument and must in particular be placed on the conveyor belt in such a way that they are not in contact with one another. Due to this high individualization demand at specific positions on the conveying section, there are increased mechanical requirements and a low throughput.

In view of this prior art the problem of the invention is to provide a method for identifying and sorting belt-conveyed objects with which, without great mechanical expenditure and effort, a type-pure separation of different objects is possible in the case of high bulk conveying. An apparatus for performing this method is also to be provided.

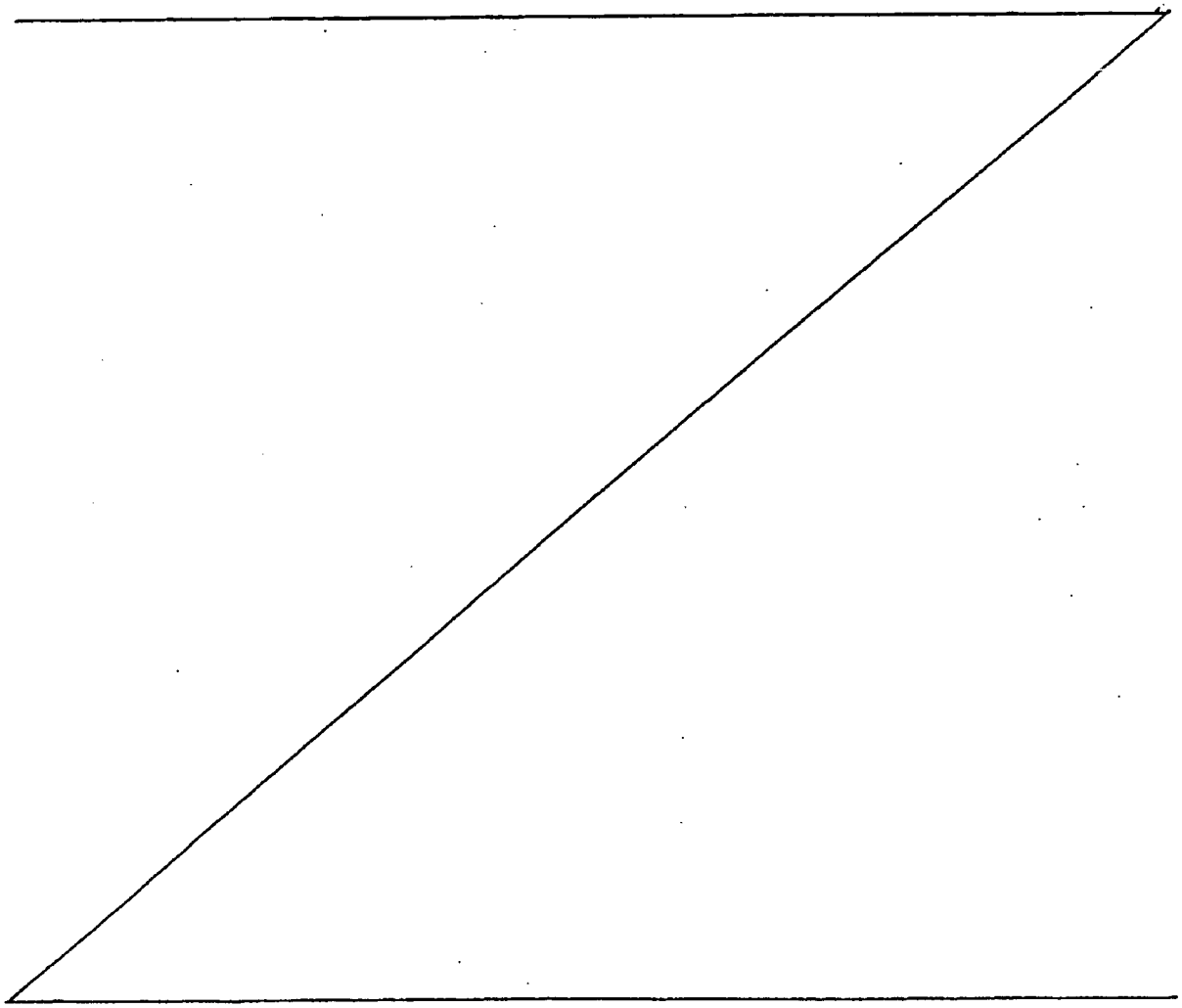
This problem is solved by a method according to claim 1 and an apparatus according to claim 5.

The method according to the invention eliminates the prior art disadvantage with respect to a complicated presorting and individualization by the provision of a relatively large-area detection zone which can be moved up to in a differentiated manner by an object-targeted scanning movement of the measurement point of the NIR measuring instrument over the object-carrying conveyor belt. Such a scanning movement is preferably obtained by means of a scanning device in the form of a mirror system for the planned aiming of the measurement point of the NIR measuring instrument on the objects.

Unlike in the case of the above-described prior art based on a special NIR measuring instrument, in the method according to the invention the NIR measuring instrument can simultaneously identify different object materials. Admittedly this fundamentally requires longer exposure and scanning times compared with the prior art NIR scanning, but this is made good by the fact

that there is no need to measure at all locations of the conveying channel and instead only where the image processing preceding the NIR measurement according to the invention has located an object.

According to the invention, upstream of the NIR spectral analysis is provided an image analysis, preferably a colour image analysis for location purposes, including optionally a shape and/or size determination of the objects to be identified. The information obtained by image analysis is used for the movement control of the scanning device positioned upstream of the NIR measuring instrument, i.e. in planned manner there is exclusively a scanning of the objects to be identified, whilst leaving untouched conveyor belt points not occupied by objects. Thus, the scanning process is rationally performed.



The image analysis also provides information on the shape, size, colour and e.g. texture which ensures a better selection.

Following an initial separation of an object fraction by means of a further (colour) image analysis based on a further camera downstream of the separation point, the objects remaining on the conveyor belt can be identified again with regards to their possibly changed position and without a further NIR spectroscopy being necessary, if the data of said camera are linked in comparative manner with the already detected NIR data. Thus, the already acquired and stored NIR values can be used during each further separating step.

Thus, in other words, the method according to the invention is based on the following principle:

Firstly there is an object (e.g. refuse) identification on a larger surface area with the aid of a colour image. It is possible to identify the position, shape, contour, size, colour and texture and store corresponding characteristic values. The material characteristics of the objects are then determined by NIR spectroscopy. Unlike the preceding image identification, the infrared radiation in NIR spectroscopy is concentrated on a single measurement point. For the transfer in planned manner of this measurement point to different locations of the conveyor belt where objects are present, a mirror system is proposed bringing the infrared rays to the desired scanning point. However, the reverse procedure is preferred in practice, i.e. the illumination of the entire determination area and the control of the measuring optics in such a way that only reflected infrared rays of desired measurement points are detected on the particular object. This mirror system is controlled with the aid of information previously acquired from the image identification. The data obtained from the (colour) image identification and infrared radiation are brought together and supply signals for the control of an apparatus for the planned discharge of objects, e.g. in the form of a blowing or blast nozzle system.

As stated only a relatively limited separation or individualization is necessary for the method according to the invention. Other complicated

preliminary operations are unnecessary. In addition, the method according to the invention ensures an identification and separation of several object fractions in a single installation. This installation can be trained without any problems for the detection of new objects in that a sufficiently large number of such new objects are placed on the conveyor belt in a learning phase.

The method and apparatus according to the invention are particularly suitable for sorting domestic refuse. However, uses other than refuse treatment are also possible, where it is a question of identifying and sorting belt-conveyed objects for other purposes.

Experience up to now has shown that the method according to the invention permits a visual location of all objects on 1 m^2 of a conveyor belt in a time less than 50 ms. For the NIR measurement of a single object typically 3 ms are necessary and the subsequent evaluation for identifying the object typically requires 1 to 2 ms. Thus, now using standard processor technologies and NIR spectrometer technologies it is possible to identify objects at belt speeds of up to 2 m/s.

The invention is described in greater detail hereinafter relative to the single drawing illustrating an embodiment of the inventive apparatus for identifying and sorting belt-conveyed objects.

The apparatus shown in the drawing comprises three apparatus complexes, namely an analysis complex 1 with a first separating complex, a second separating complex 2 and a third separating complex 3. Each of these three complexes 1, 2 and 3 comprises a continuous belt conveyor 4, 5 and 6 with conveyor belts 7, 8 and 9, all of which are located in the same horizontal plane and are connected to one another accompanied by the interposing of blasting nozzle strips. Particularly between the downstream end of the belt conveyor 4 and the upstream end of the belt conveyor 5 is placed a blasting nozzle strip 10 and between the downstream end of the belt conveyor 5 and the upstream end of the belt conveyor 6 is positioned a blasting nozzle strip 11. Each of the blasting nozzle strips extends over the full width of the particular conveyor belt 7, 8 or 9, is directly connected at the corresponding

reversal ends thereof and is relatively narrow to ensure that objects conveyed on the conveying section formed by the conveyor belts 7, 8 and 9 can pass without difficulty over the blasting nozzle strips 10, 11. As shown in the drawing by thick black dots, a plurality of blasting nozzle orifices extend transversely over the blasting nozzle strips 10 and 11.

The conveying section established by the belt conveyors or their conveyor belts, together the associated units to be explained in greater detail hereinafter, are e.g. used for refuse sorting.

For identifying the objects conveyed on the conveying section the analysis complex 1 above the belt conveyor 4 of said complex has a colour camera 12, a NIR spectrometer 13 with a NIR sensor 14 and an optical scanning head 15. For controlling said units a computer 16 is provided and is preferably positioned at a distance from the units 12 to 14 and can also be integrated into the computer network, as described hereinafter. The outputs of the colour camera 12 and NIR spectrometer 13 are connected to the corresponding inputs of the computer 16. The NIR sensor 14, which can also form an integral component of the NIR spectrometer 13, is connected to the NIR spectrometer for the transmission of measured values.

The optical scanning head 15 comprises a per se known (mirro) lens arrangement, which e.g. in motor-driven manner can be so displaced that a determination area on the conveyor belt 7 is scanned in punctiform manner, the scanned measurement point being inputted into the NIR sensor. The drawing shows in exemplified manner a measurement point 19. The optical scanning head 15 is designed in such a way that the determination area 18 is rectangular, extending over the full width of the conveyor belt 7 and typically having a given length in the conveying direction. Typically the determination area 18 has a surface area of approximately 1 m^2 when using a standard conveyor belt of width 100 cm.

In order to be able to correlate in problem-free, informative manner the measured values obtained with the NIR spectrometer 13 by means of the scanning head 15 with measured values of the colour camera 12, the shape and size of the determination area 17 of the colour camera 12 coincide with those of

the determination area 18, i.e. area 17 is also rectangular and extends over the full width of the conveyor belt 7. Thus, the analysis complex 1 is characterized by two determination areas, namely a determination area 17 in which the configuration and/or surface characteristics and position of the objects on the conveyor belt 7 are determined and a determination area 18 downstream of the area 17 for determining the material characteristics of said objects.

The computer 16 evaluates the output data of the colour camera 12 and the output data of the NIR spectrometer 13. By the application of an image analysis process objects on the belt conveyor can be classified and positionally detected with regards to shape, size, colority, texture, etc. NIR spectroscopy permits a high spectral resolution of e.g. up to 256 (512) frequency channels of a width of approximately 2 to 4 nm at a single, spatial measurement location. From all this information conclusions can be drawn concerning the material characteristics at the measurement location or on the object. If the spatial resolution of the camera 12 in the visible range is combined with a rapid control of the NIR measurement location over the particular determination area 17 to 18 of approximately 1 m^2, it is possible to simulate a NIR measurement with spatial resolution. This gives a very reliable object location and identification without complicated object individualization being necessary beforehand. Thus, any preseparation which is necessary applies only to the differentiation of the objects in plan view.

After locating and identifying the objects in analysis complex 1, after leaving the conveyor belt 7 they reach the blasting nozzle strip 10 and are blown by the air jets passing out there in the direction of the arrow 20 into a collecting device 21 positioned over the conveying section and the blown objects are discharged from the collecting device 21, e.g. via a chute or a transverse conveyor 21a.

The remaining objects then pass onto the conveyor belt 8 of the first separating complex 2. Above said conveyor belt 8 is located a further colour camera 22, which in much the same way as the colour camera 12 of the analysis complex 1 is connected to the computer 16 and is used for detecting an area 23 on the conveyor belt 8. Alternatively with the first separating

complex 2 (and also the further downstream separating complexes, such as e.g. the separating complex 3) can be associated an individual computer, which is linked with the computer 16 in the manner described hereinbefore. This determination area 23 has the same shape format and relative position with respect to the conveyor belt 8 as the determination areas 17, 18 to the conveyor belt 7 of the first analysis complex. The determination data from the colour camera 22 processed in the computer 16 make it possible to detect the remaining objects and possibly their position change. By matching said data with the data acquired in analysis complex 1 and stored in the computer 16, it is ensured that the image analysis which has taken place in analysis complex 1 is automatically "held" without a further NIR spectroscopy being necessary. In fact the previously obtained NIR values stored in the computer 16 are used for a further separating step, which takes place downstream of the first separating complex and namely through the blasting nozzle strip 11 between the belt conveyor 5 and the belt conveyor 6. By means of the blasting nozzle strip 11 in planned manner objects are discharged in the direction of an arrow 24 to a collecting device 25 and from there via a chute or a transverse conveyor 25a.

The second separating complex 3 is identical to the first separating complex 2 and consequently has a further colour camera 26, which detects an area 27 on the conveyor belt 9 and the size and shape thereof correspond to those of the preceding determination areas. The operation of the second separating complex 3 corresponds to that of the previously explained first separating complex with the difference that the image data are used as reference data, which are detected by the colour camera 22 of the first separating complex instead of data provided by the colour camera 12 of the analysis complex.

The previously described apparatus according to the invention is not restricted to the represented installation with only three separating complexes. In accordance with the given requirements, it is also possible to use more separating complexes or a single separating complex.

It is not vital for the cameras 12, 22 and 26 to be colour cameras and optionally black and white cameras can also be used.

CLAIMS

1. Method for identifying and sorting belt-conveyed objects, particularly for refuse sorting, in which the material characteristics of the objects are spectroscopically determined by means of a NIR measuring instrument (13) and sorting takes place as a function of the spectroscopy result by removing objects from the conveyor belt (7, 8, 9), characterized in that the conveyor belt (7, 8, 9) is scanned in a predetermined area (17) over its entire width in order to locate each object in said area (17) on the basis of the object position on the conveyor belt (7, 8, 9) and the shape thereof, that exclusively the surface characteristics are determined (12) at the location of the located objects whilst leaving untouched unoccupied locations of the conveyor belt (7, 8, 9), different object materials being simultaneously identified by the NIR measuring instrument (13) and that the objects are scanned through the measurement point (19) of the NIR measuring instrument (13) as a function of at least their previously determined position and are removed from the conveyor belt (7, 8, 9).

2. Method according to claim 1, characterized in that the position of the objects, whose material characteristics have been determined (12) and stored, is determined at least one further time (22, 36) following a first object removal process.

3. Method according to claim 1 or 2, characterized in that in addition to the position of the objects, their size is determined.

4. Method according to claim 1 or 2, characterized in that the data acquired during the determination of the position, shape and surface characteristics and/or size are supplied to an image processing means (16) and the thus processed data are linked with data concerning the material characteristics.

5. Apparatus for identifying and sorting belt-conveyed objects, with a NIR measuring instrument (13) located at a first determination area (18) over a conveyor belt (7) and which is followed by at least one separating point (10) for removing objects from the conveyor belt (7), characterized in that

upstream of the first determination area (18) is provided a device (12) for the optical detection of the objects in a second determination area (17) over the entire width of the conveyor belt (7), that a device (16) for image processing or identification is provided, which processes measured signals of the device (12) for the optical detection of objects in order to determine the position and shape of the objects on the conveyor belt (7), so as to link data concerning the object position and shape with the measured results of the NIR instrument (13) and that with the NIR instrument (13), which is in a position to simultaneously identify different object materials, is associated a device (15) for the scanning movement of a measurement point (19) over the objects on the conveyor belt (7) only where an object is located.

6. Apparatus according to claim 5, characterized in that the scanning device (15) has a mirror system for guiding the measurement point of the NIR instrument (13) over the determination area (18).

7. Apparatus according to claim 5 or 6, characterized in that the separating point (10) is followed by at least one further separating point (11), upstream of which in a third determination location (23) is provided a further device (22) for the optical detection of objects and that the detection results thereof are matched with position data concerning the objects.

8. Apparatus according to one of the claims 5 to 7, characterized in that the devices (12, 22, 26) for the optical detection of objects is a camera.

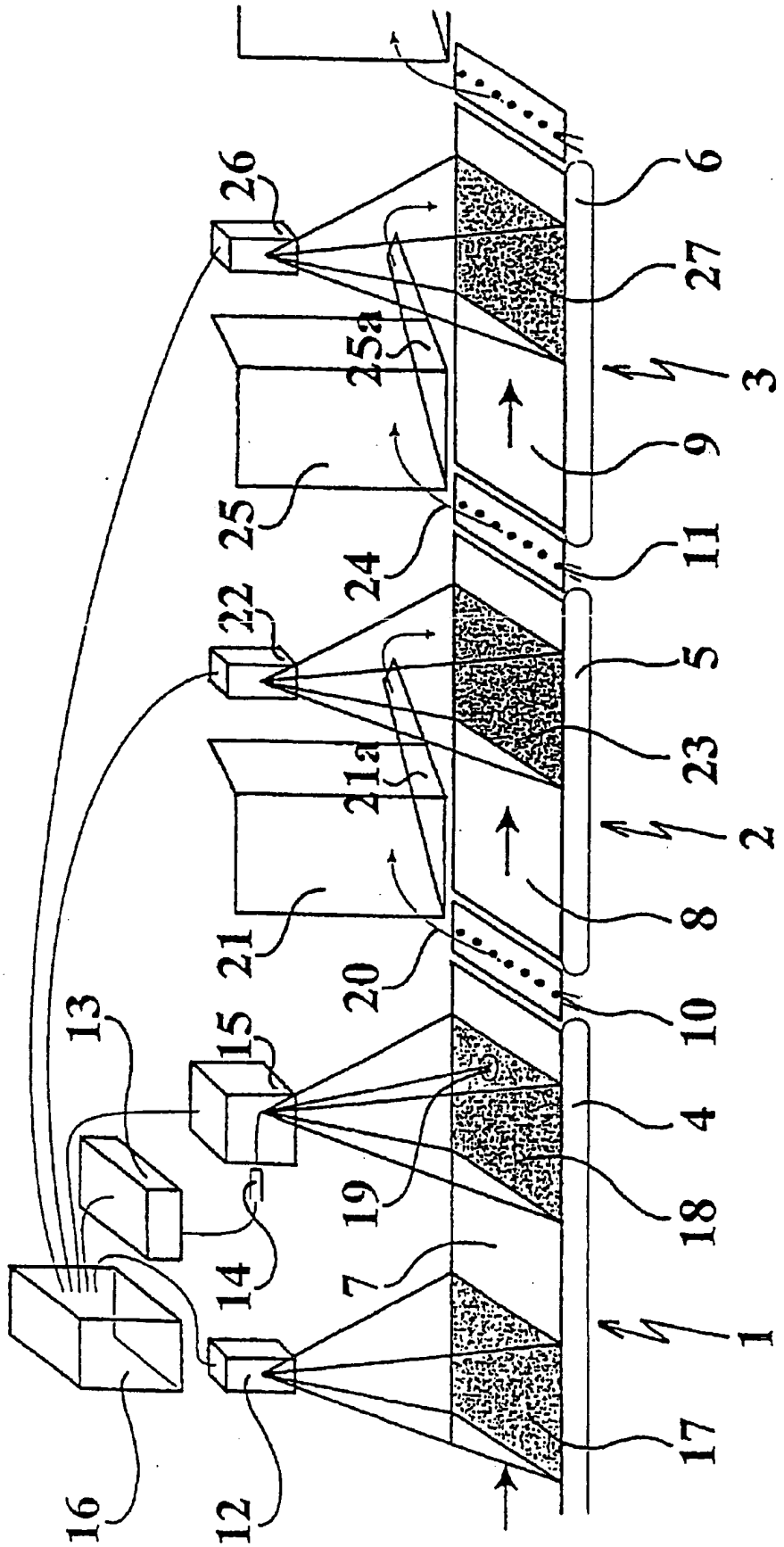

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Fig. 1